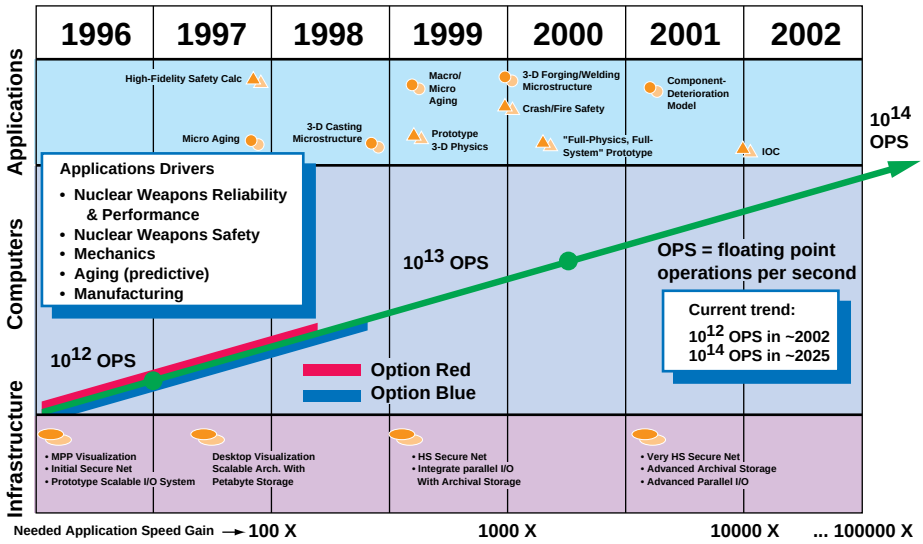
Accelerated Strategic Computing Initiative (ASCI)



Achieving Stockpile Stewardship objectives requires rapid advances in capability.

On September 24, 1996, President Bill Clinton became the first world leader to sign the Comprehensive Test Ban Treaty. This ushered in a new era in the way the United States ensures confidence in the safety, performance, and reliability of its nuclear stockpile. As President Clinton stated on August 11, 1995, " . . . we can meet the challenge of maintaining our nuclear deterrent under a [comprehensive test ban] through a science-based stockpile stewardship program without nuclear testing." Other key aspects of this new era include the U.S. decisions to halt new nuclear weapons designs and to drastically reduce its weapons manufacturing infrastructure. This means that the U.S. nuclear weapons stockpile will need to be maintained far beyond its design lifetime without either nuclear testing or its traditional manufacturing support system.

The ability to assess nuclear weapons, analyze their performance, predict their safety and reliability, and certify their functionality as they age is essential for conscientious management of the enduring stockpile. Accelerated Strategic Computing Initiative's (ASCI's) vision is to shift promptly from nuclear test-based methods to computational-based methods for ensuring the safety, reliability, and performance of our nuclear weapons stockpile. ASCI will create predictive simulation and virtual prototyping capabilities based on advanced weapon codes, and it will accelerate the development of high-performance computing far beyond what might be achieved in the absence of a focused initiative. ASCI will provide the ability to assess, evaluate, maintain, and prototype nuclear weapons and weapons components in the absence of nuclear testing and with a greatly reduced weapons manufacturing infrastructure.

ASCI will complement the Stockpile Stewardship and Management Program (SSMP) and the Core Computation Program by advancing the Department of Energy (DOE) Defense Program's computational capabilities to meet the future needs of stockpile stewardship. The problems that ASCI will solve for the SSMP span the activities and responsibilities of the three Defense Program laboratories: Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and Sandia National Laboratories. Cooperation is essential to the solution of these problems—the Defense Program laboratories will participate in the ASCI Program as partners.

ASCI is a focused and balanced program that will extend the DOE's computational resources to create predictive simulation and virtual prototyping capabilities for nuclear weapons. By 2010, the ASCI Program will

- develop high-performance, full-system, high-fidelity predictive codes to support weapons design, production analysis, accident analysis, and certification;
- stimulate the U.S. computer manufacturing industry to create more powerful, high-end supercomputing capability required by these applications; and
- create a computational infrastructure and operating environment that makes these capabilities accessible and usable.

Program Plan

The ASCI Program has four main objectives.

Performance: Create predictive simulations of nuclear weapon systems to analyze behavior and assess performance in an environment without nuclear testing.

Safety: Predict with high certainty the behavior of full weapons systems in complex accident scenarios.

Reliability: Achieve sufficient, validated predictive capabilities to extend the lifetime of the stockpile, predict failure mechanisms, and reduce routine maintenance.

Renewal: Use virtual prototyping to reduce production and testing facilities for stockpile requalification and replacement work.

Each of these objectives requires computational capabilities that do not currently exist. Five strategies have been identified for meeting program objectives. Together, these strategies compose a balanced program that will create predictive simulation and virtual prototyping capabilities.

ASCI Accelerated Strategic Computing Initiative

ASCI Strategies

Create Seamless Management: One Program—Tri-Lab

- Operate ASCI as a three-lab, single-program activity with seamless management and execution across the laboratories.
- Collaborate on development and share hardware and software resources.
- Take maximum advantage of standard tools, common system structures, and code portability to enable interlaboratory collaboration.

Focus on Advanced Applications Development

- Focus on 3D, high-fidelity, full-systems weapons simulation applications.
- Accelerate code performance on ASCI platforms.
- Validate simulations by rigorous correlation with constrained experiments and archival data.

Focus on High-End Computing

- Accelerate the development of very high performance, scalable architectures.
- Develop partnerships with multiple vendors to ensure appropriate technology development and worldwide leadership.

Create Problem-Solving Environments

- Provide support for the rapid development of large, complex, scalable applications.
- Develop a computational infrastructure that supports efficient use of ASCI platforms and is accessible from users' desktops.
- Develop a Tri-Lab distributed computing environment.

Encourage Strategic Alliances and Collaborations

- Establish long-term strategic alliances with universities to develop critical mass efforts dedicated to long-term ASCI issues.
- Establish smaller-scale collaborations with individual investigators to work on more narrowly focused problems.
- Develop task-oriented collaborations closely linked with specific ASCI deliverables.

Initial Results

- Platform R&D partnerships include (1) Intel for a 1.8-Tflop peak system to be located at Sandia in FY97, (2) IBM for a 3.2-t teraflop system to be located at Lawrence Livermore National Laboratory in FY99, and (3) SGI/CRI to place a 3.1-tflops system at Los Alamos National Laboratory in FY99.
- Eleven next-generation weapons simulations codes in the areas of safety, performance, and manufacturing have been initiated.
- The first high-speed, secure network linking Sandia, Los Alamos, and Lawrence Livermore national laboratories is in daily use.

U.S. Technology Benefits

The United States has traditionally viewed its leadership in very high performance computers as a strategic economic advantage. ASCI's platform R&D partnerships will ensure that this leadership continues. The computer technology and products developed in ASCI will be applied to a broad spectrum of national needs.

The computer-based predictive capabilities developed in ASCI will bring economic and scientific benefits to the U.S. Solutions to numerous challenging computational problems await improvements in peak-performance computing hardware and applications. Many of these problems are in the fields of environmental studies, biology and biochemistry, consumer product safety, and information management and access. The computing environment and data analysis tools to be developed by ASCI will help attack these problems. ASCI also addresses environmental concerns. Predictive simulation for stockpile stewardship avoids the environmental damage of underground testing and uncontained aboveground experiments. Although some aboveground experiments are essential to provide data for ASCI applications development, the multiple experiments needed for parametric studies of design variations can be done through predictive simulation.

In addition to helping preserve the environment, predictive simulation and virtual prototyping will provide direct economic benefits. Virtual prototyping will drastically reduce the lead time for component design, development, testing, and fabrication. A faster lead time will reduce the cost of product development, which will enable unprecedented efficiencies and lead to lower manufacturing costs and greater economic competitiveness in U.S. manufacturing.

Relationship to Stockpile Stewardship Initiatives

ASCI is not a program unto itself but an integral part of the Stockpile Stewardship and Management Program. ASCI will take experimental data from the aboveground test facilities and link it into weapons-appropriate predictive capabilities. In addition, ASCI will provide virtual prototyping capability for the Advanced Design and Production Technologies initiative and will rely heavily on the ongoing efforts of the Defense Program's core research program for advances in physics, material sciences, and computational modeling. ASCI will also act in partnership with the National Ignition Facility and the tritium production programs to address issues of stockpile stewardship ■

For more information contact:
Don McCoy, LANL, 505-667-4236,
dmccoy@lanl.gov

David Nowak, LLNL, 510-423-6796,
dnowak@llnl.gov

William Camp,
SNL, 505-845-7655,
wjcamp@sandia.gov

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